# INSTRUCTION MANUAL

FOR

TRACE OXYGEN ANALYZER

MODEL 310

SERIAL NUMBER:

RANGES: 0-10, 100, 1000, 10,000 PPM OXYGEN

CUSTOMER ORDER NUMBER:

SALES ORDER NUMBER:

TELEDYNE ANALYTICAL INSTRUMENTS
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(213) 961-9221 - (213) 283-7181

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1. INTRODUCTION

1.1 Method of Analysis. The Teledyne Analytical Instruments (TAI) Series 310 Portable Trace Oxygen Analyzer utilizes a unique, patented micro-fuel cell to electrochemically measure the concentration of oxygen in a gas stream. The cell has an absolute zero and produces a linear output from the low parts per million (ppm) level through 21% (210,000 ppm) oxygen. When coupled with a "state of the art" two stage amplifier system that incorporates a hybrid operational amplifier and an integrated circuit (IC), the cell provides linear trace oxygen analysis in the ranges of 0-10, 0-100, 0-1,000, and 0-10,000 ppm. No zero gas is required, and the instrument may be calibrated with air (obviating the use of questionable "certified" trace oxygen calibration gases).

1.2 Standard Features. The following outstanding features are incorporated in the Series 310 Portable Trace Oxygen Analyzer line:

1.2.1 Micro-Fuel Cell. The Series 310 sets a new standard in maintenance-free operation. The micro-fuel cell is a sealed electrochemical transducer with no electrolyte to change or electrodes to clean. When the cell reaches the end of its useful life (6 months minimum), it is merely thrown away and replaced, as one would replace a battery in a flashlight.

The cell is specific for oxygen and is not influenced by sample flow rate or the presence of reducing agents, such as hydrocarbons, CO, $SO_2$, etc. When a nominal flowrate of 0.25 scfh (approximately 150 cc/min) is maintained through the instrument, the response time is 90% in less than 10 seconds for most ranges. The instrument can also be installed in a glove box to provide ppm oxygen analysis by diffusion sampling only.

1.2.2 Temperature Compensation. The Series 310 utilizes a thermistor controlled temperature compensation circuit to maintain ± 5% of reading or ± 2% of scale accuracy (whichever is greater) over the operating temperature range (30 to 125°F). Employing the compensation approach, rather than temperature control method, provides acceptable accuracy

over a wide range of ambient temperature fluctuation and eliminates the maintenance problems that normally accompany the components associated with an electrical heating system.

1.2.3 Meter Readout. The Series 310 is equipped with an exceptionally accurate (± 0.5% linearity) panel meter for direct readout of the analysis. A linear 100 division scale (mirror equipped to eliminate parallex) promotes reliable, accurate readout of the analysis at any point on the scale. The resolution and accuracy of the instrument's meter obviates the necessity of an accessory readout device -- unless a permanent recording of the analysis is required.

Integral single and double alarm circuitry (see optional feature) is also available.

1.2.4 Output Signal. For those applications requiring a continuous recording of the oxygen content of the sample, a linear output signal of from 0-1 millivolt to 0-1 volt D.C. is available at no extra charge. Unless otherwise specified at the time of purchase, the output signal will be 0-1 volt D.C.

The output signal, regardless of magnitude, is suitable for driving external devices that have an input impedance of 10,000 ohms or more.

1.2.5 Multiple Ranges of Analysis. The Series 310 accurately measures oxygen concentrations from 0-10 ppm to 0-10,000 ppm (full scale). Range adjustment is in decade steps, and is accomplished by the positioning of a selector switch. Each range of analysis is identified by the multiplying factor that is to be applied to the basic 10 major divisions of the integral meter scale; i.e., X1 would be 0-10 ppm oxygen full scale, X10, 0-100 ppm oxygen, and so on.

In addition, a "CAL" position is provided to extend the range of measurement to include the oxygen concentration of air. With the selector in this position, the instrument may be accurately calibrated by drawing air through the cell manifold and using the "CAL" mark on the meter dial to set the span control.

1.2.6 Speed of Response. With a sample flowrate of 0.25 scfh, the Series 310 achieves 90% response in 10 seconds

to full scale changes in oxygen concentration in the X10, X100 and X1000 ranges. In the X1 range, 90% response is realized in 30 seconds. In general, the response of the micro-fuel cell is significantly superior to that of most portable electrochemical trace oxygen measuring systems currently on the market.

1.2.7 Compact Packaging. The analyzer is housed in an aluminum case that is equipped with a carrying handle for easy portability. When in use, the analyzer should be placed in an upright position on a level surface (off level positioning will detract from the meter accuracy).

Access to the instrument components is gained by loosening (ccw) the three (3) quarter turn fasteners on the back of the outer case. The outer case may then be detached from the control panel. The instrument may be further disassembled by first removing the back plate assembly, and then the printed circuit board (or boards) from their respective standoffs. These assemblies may be removed without disturbing the integral wiring. The disassembled units then lay out as pictured on the "Analyzer Wiring Diagram" -- which is included among the drawings at the rear of the manual.

The instrument is equipped with two (2) quick disconnect type tubing fittings, each of which features an integral shutoff valve that automatically closes when its mating fitting is disengaged. The fittings are an integral part of the micro-fuel cell manifold, and project through the rear of the instrument. TAI also provides three (3) male fittings for the instrument, one of which is equipped with a plastic tube. The tubing equipped fitting is used to draw air through the instrument for calibration purposes (See Section 3 of the manual).

An eight foot detachable power cord is also furnished with the analyzer.

1.3 Optional Feature. The basic Model 310 analyzer incorporates all the standard features listed in Section 1.2 of the manual. The following optional feature is also available upon request:

1.3.1 Integral Alarm Circuitry. One (Model 310-1)

or two (Model 310-2) independently adjustable control circuits are available as an accessory option.

Control over an external circuit is achieved by a relay whose solenoid coil is operated by an electronic "comparator" circuit. The switch contacts of the relay are interconnected with the customer's circuit on the terminal strip at the rear of the instrument. The control point at which the relay operates is determined by the setting of a dial equipped potentiometer on the control panel. The linearity of the oxygen signal and 10 turn "set point" potentiometer, plus the resolution (1,000 discrete divisions) of the turns counting control dial, provides precise monitoring of any oxygen concentration within the range capability of the analyzer. The decade nature of the ranges of analysis and the set point dial permits the user to set his control by simply dialing the control until it reads the desired oxygen level. The only mental calculation required is the proper placement of the decimal point, as the meter scale has 100 divisions and the control dial 1,000, plus allowances must be made for the fact that relay action will occur at the same spot on the scale regardless of range switch position.

The integral control circuitry can be arranged so that the relay is energized either above or below the set point. <u>Unless otherwise specified</u>, the control relay in a single set point instrument (Model 310-1) will be <u>energized below</u> the set point, and the relays in a double set point instrument (Model 310-2) will be <u>energized</u> when the oxygen level is reading <u>above set point #1 and below set point #2</u>.

Each alarm relay energizes a red indicator light that is associated with its respective set point. Normally (see previous paragraph), the light illuminates when its respective relay is in a <u>de-energized</u> condition (set point exceeded).

## 2. SUPPORTING EQUIPMENT AND SERVICES.

2.1 <u>Power Service</u>. A source of single phase, 105 to 125 volt, 50 or 60 cycle power, capable of delivering a 1/4 ampere of current continuously, is required to operate the Series 310 analyzer.

The analyzer is supplied with a UAL approved 3 wire detachable power cord. Under no circumstances bypass the ground lead of the cord. Aside from eliminating personnel short circuit protection, bypassing the ground wire will deprive the instruments electronic circuitry of an earth ground reference -- which could lead to erratic, unreliable performance.

2.2 Sampling Equipment. The customer must provide the necessary flow control hardware for positive pressure applications; TAI suggests a simple throttle valve installed in the sample line between the sample point and the analyzer. The flowrate should be limited to between 0.1 and 10 liters/min. for atmospheric pressure sampling, connect a pump downstream from the analyzer, and draw (rather than push) the sample through the instrument.

2.3 External Signal. All models of the Series 310 are equipped to provide an output signal. The magnitude of the available signal can be preset by TAI from 0-1 millivolt DC (full scale) to 0-1 volt DC (full scale) and should be specified by the customer at the time of purchase. Unless otherwise specified, the output will be 0-1 volt DC. Refer to the "Specification Data" Section of the Manual to determine the output signal magnitude.

The output signal, regardless of magnitude, is suitable for driving external devices that have an input impedance of 10,000 ohms or more.

Two conductor shielded cable is recommended for interconnection purposes (particularly for those instruments whose output signal magnitude is in the lower millivolt range). Polarize the signal connections as shown on the "Pictorial Diagram", and connect the shield at the external readout device only.

2.4 External Alarms. Models 310-1 and 310-2 feature integral, adjustable alarm control circuits (see Section 1.3.1 for descriptive information).

The form "C" contacts (normally closed-common-normally open) of the relay (or relays) are electrically terminated on the rear terminal strip. In order to properly use the SPDT switch

that these contacts represent, the customer must first ascertain when the relay (or relays) is energized (above or below set point). When applicable, this information will be found documented in the "Specification Data" section of the manual. The appropriate terminal strip connections for both models are identified on the "Pictorial Diagram".

The load current of the circuit being controlled by either of the set point relays should be no greater than 5 amperes (non-inductive).

## 3. OPERATION

3.1 Introduction. The Series 310 is supplied completely assembled and ready for instant use. The micro-fuel cell is in place within the manifold, and prior to shipment, the manifold was purged with an inert gas to eliminate all but traces of oxygen from the internal sampling system. The integral shutoff valves in the quick disconnect sample fittings, if not disturbed, will maintain this inert atmosphere within the manifold indefinitely. This can be demonstrated by connecting the power cord and advancing the range selector switch to the X100 (0-1,000 ppm) position.

When the range selector is advanced from the "OFF" position, power to the instruments circuitry is established. The meter may drive downscale off the zero mark momentarily when power is first applied -- but will move upscale and come to balance shortly thereafter.

It is impossible to achieve a "perfect" seal of the internal sample system, and what the meter is indicating is the diffusion -- consumption balance point of internal sample system and the micro-fuel cell.

This "balance" point, with a properly calibrated instrument, is always within the limits of the X100 range. If the reading climbs off the limits of this scale, a leak in the manifold assembly is indicated.

TO EXTEND CELL LIFE AND MINIMIZE THE TIME REQUIRED TO MAKE THE NEXT ANALYSIS, THE INSTRUMENT SHOULD ALWAYS BE PURGED WITH THE SAMPLE OR AN INERT GAS PRIOR TO BEING TAKEN OUT OF SERVICE FOR STANDBY OR STORAGE.

3.2 Calibration. The inherently constant output of the cell during its useful life precludes a definitive calibration cycle. TAI feels that the interval between calibrations should be dictated by the customer's application. If the instrument is being used to certify the oxygen content of a product for delivery, then, a calibration prior to certification would certainly be in order. If, on the other hand, the instrument is being used to monitor or guard a sample for predetermined limits of acceptability, the customer's knowledge of that sample and the evidence provided by the analyzer will in themselves determine when a calibration check is in order.

DO NOT CALIBRATE THE INSTRUMENT UNLESS THERE IS A TRACE OXYGEN GAS READILY AVAILABLE FOR PURGING IMMEDIATELY FOLLOWING THE CALIBRATION PROCEDURE.

3.2.1 Calibration Procedure. Employ the following step by step procedure to calibrate the instrument.

1) Stand the instrument upright on a level surface, and with the range switch in the "OFF" position, check the alignment of the meter pointer with the zero mark on the scale. Use the mirror to eliminate parallex, and adjust the screw on the face of the meter, if necessary, until the pointer and zero mark are in precise coincidence.

2) Advance the range switch to the "CAL" position.

3) Install the plastic tube equipped male disconnect fitting in either of the analyzer's sample ports, and a blank disconnect fitting in the other port (direction of sample flow is of no importance). Gently suck (do not blow) on the plastic tube and observe the meter reading. Continue to suck on the tube until the meter reading is stable.

4) Unlock and adjust the span control until the meter pointer is in coincidence with the "CAL" mark on the meter scale. BE SURE TO RELOCK THE CONTROL AFTER THE ADJUSTMENT IS MADE.

5) Immediately after step 4 has been accomplished, disconnect the tubing equipped calibration fitting, and plug in either the sample or a source of inert gas.

If the instrument is to be used for sampling after the calibration procedure has been completed, follow the decreasing oxygen reading by positioning the range switch so that the meter gives the best possible resolution of the oxygen. DO NOT ATTEMPT TO ACTUALLY TAKE A READING UNTIL THE METER INDICATION STABILIZES. If the sample oxygen content lies within the limits of the X1 range (0-10 ppm), it will take about fifteen minutes for the instrument to recover sufficiently from the effects of the 209,000 ppm oxygen concentration of air (over four decades of range differential). Recovery time is proportionally less for coarser ranges.

If, on the other hand, the instrument is not to be used immediately after calibration, and a low ppm oxygen gas is being employed as a purge, allow the reading to stabilize, and then disconnect both male fittings. ALWAYS DISCONNECT THE SOURCE FITTING FIRST, AND IMMEDIATELY THEREAFTER, THE VENT FITTING.

3.3 Positive Pressure Sampling. When connecting the instrument to a positive pressure sample source, ALWAYS proceed as follows:

1) Before making any connections to the instrument, establish a flowrate in the sample line of from 0.1 to 10 liters/min. Allow the sample to vent to atmosphere long enough to purge the line free of air.

2) Install the vent fitting first, and then the sample source fitting. Be prepared to make the connections in rapid order, so that atmospheric diffusion time through the vent fitting is held to a minimum.

When disconnecting the instrument, reverse the procedure; source fitting first, and then vent fitting.

The objective of the connection - disconnection procedure is to obviate the possibility of pressurizing the cell. IF A FLOWING SAMPLE WAS CONNECTED TO THE MANIFOLD WITHOUT THE VENT FITTING IN PLACE, THE PRESSURE IN THE MANIFOLD WOULD RISE AND BE EQUAL TO THE SAMPLE PRESSURE ALMOST IMMEDIATELY. In such a situation, depending on the magnitude of the sample pressure, the cell could be permanently damaged.

3.4 Atmospheric Pressure Sampling. If the sample is at atmospheric pressure (or slightly negative), a sample pump will be required downstream from the analyzer. The inlet side of the pump should also be equipped with a throttle valve -- so that sample flow can be reduced to between 0.1 and 10 liters/min. If pump loading is a consideration, the inlet side of the pump will have to include a bypass path that is open to the atmosphere through still another throttle valve. The sample path and bypass path may then be balanced by manipulating the two valves, so that the sample flow is within the prescribed limits without loading the pump.

UNDER NO CIRCUMSTANCES SHOULD THERE BE ANY RESTRICTIONS IN THE LINE BETWEEN THE SAMPLE POINT AND THE ANALYZER -- as a partial vacuum would then be drawn on the cell. Since the cell is a partial pressure sensitive device, any oxygen readings taken under these conditions would be erroneous.

## 4. MAINTENANCE

4.1 Routine Maintenance. No routine, periodic maintenanace is required. The only moving parts contained in the analyzer are the meter movement and the plug-in relay (or relays). The micro-fuel cell is a sealed, modular component that can only be replaced when at fault.

4.2 Cell Replacement. The characteristics of the micro-fuel cell are similar to those of a nickel cadmium battery in that both provide an almost constant output through their useful life, and then fall off sharply towards zero at the end. If the sample being analyzed has low X1 range oxygen concentration, cell failure will probably be indicated by the inability to properly calibrate the analyzer. The user will find that very little adjustment of the 10-turn span potentiometer will be required to keep the analyzer calibrated properly during the duration of a given cell's useful life. If large, many turn adjustments (cw) are required to calibrate the instrument, or calibration cannot be achieved within the range of the control, the cell should be immediately replaced.

To offset the possibility of not having a replacement cell available when it is needed, TAI recommends that a spare cell be purchased shortly after the instrument is placed in service, and each time the cell is replaced thereafter.

The spare cell should be carefully stored in an area that is not subject to large variations in ambient temperature (75° F nominal), and in such a way as to obviate any possibility of incurring damage. Under no circumstances, disturb the integrity of the cell package until the cell is to be actually used. If the cell package is punctured and air permitted to enter, the cell will immediately start to react to the presence of oxygen.

Packaged spare cells are equipped with a removable shorting clip. While in storage, the cell should be inspected periodically for electrolyte leakage. If a cell is leaking, the shorting clip will turn black in color, and in severe cases, actually break into several pieces. If either of these symptoms are detected, return the cell to TAI for replacement. DO NOT DISTURB THE CELL PACKAGE. If the cell package is intact, TAI will replace the cell at no cost.

No tools are required to replace the cell in the instrument. Simply unscrew (ccw) the plug at the bottom of the analyzer and the cell will drop out of the manifold cavity.

Remove the new cell from its package, and carefully remove the shorting clip and the paper sticker that is in place over the sensing surface of the cell. Do not touch the gold colored sensing surface of the cell -- as it is covered with a delicate teflon membrane that can be ruptured in handling.

Place the cell on the end of the manifold plug -- so that the sensing surface of the cell is in contact with the plug and the electrical contact plate end of the cell is facing upwards. Insert the cell and plug in the manifold cavity, and screw the plug back into place. Apply as much pressure as you can with your fingers, but use no tools.

After the cell has been installed, purge the instrument

with an inert gas (or the sample), and then proceed as directed in Section 3.2.1.

4.3 Cell Warranty. The Class B-2 cell employed in the Series 310 is warranted for 60,000 percent-hours or six (6) months of service (whichever occurs first).

With regard to spare cells, service time starts when the cell is removed from its shipping package. The customer should stock only one spare cell per instrument at a time. Do not attempt to stockpile spare cells.

The Series 310 should not be used in applications where $CO_2$ is a major component in the sample. Concentrations of 1,000 ppm or less will not effect the cell performance. The following page is a graph showing the effects of $CO_2$ on cell life.

If a cell was working satisfactorily, but ceases to function before the warranty period expires, the customer will receive credit, on a pro-rated basis, toward the purchase of a new cell.

Customers having warranty claims must return the cell in question to the factory for evaluation. If it is determined that failure is due to faulty workmanship or material, the cell will be replaced at no cost to the customer. WARNING: Evidence of damage due to tampering or mishandling will render the cell warranty null and void.

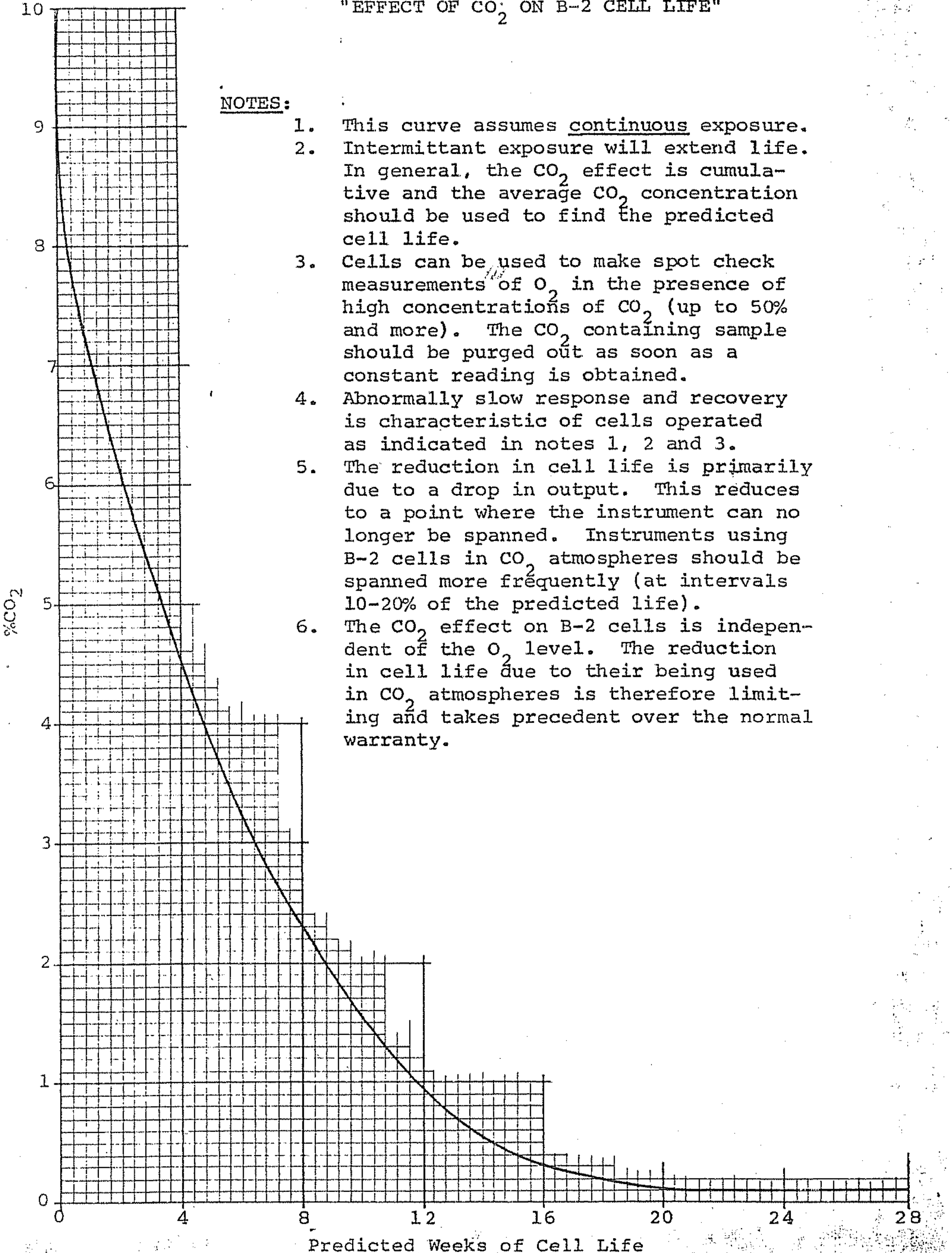
## 5. TECHNICAL INFORMATION

5.1 Transduction and Temperature Compensation. The TAI Series 310 Trace Oxygen Analyzer utilizes a unique electrochemical transducer whose features include:

1) Specificity for oxygen.
2) Maintenance free operation.
3) Long calibration interval and life.
4) Disposable configuration.
5) Low cost.

The transducer functions as a fuel cell; in this instance, the fuel is oxygen. Oxygen diffusing into the cell reacts

"EFFECT OF $CO_2$ ON B-2 CELL LIFE"




NOTES:

1. This curve assumes continuous exposure.
2. Intermittant exposure will extend life. In general, the $CO_2$ effect is cumulative and the average $CO_2$ concentration should be used to find the predicted cell life.
3. Cells can be used to make spot check measurements of $O_2$ in the presence of high concentrations of $CO_2$ (up to 50% and more). The $CO_2$ containing sample should be purged out as soon as a constant reading is obtained.
4. Abnormally slow response and recovery is characteristic of cells operated as indicated in notes 1, 2 and 3.
5. The reduction in cell life is primarily due to a drop in output. This reduces to a point where the instrument can no longer be spanned. Instruments using B-2 cells in $CO_2$ atmospheres should be spanned more frequently (at intervals 10-20% of the predicted life).
6. The $CO_2$ effect on B-2 cells is independent of the $O_2$ level. The reduction in cell life due to their being used in $CO_2$ atmospheres is therefore limiting and takes precedent over the normal warranty.

chemically to produce an electrical current that is proportional to the oxygen concentration in the gas phase immediately adjacent to the cells sensing surface.

The cell has an inherent positive temperature coefficient, the effects of which have been minimized through the implementation of a calibrated thermistor compensation circuit. The instrument is cycled through the operating temperature range (30 to 125°F) and the value of resistor R21 (see schematic) will produce the advertised accuracy specification (± 2% of scale of ± 5% of reading, whichever is greater). The reader should understand that the ± 5% of reading specification is a derivative of the wide operating temperature range, and that at a constant temperature, the accuracy is ± 2% of scale.

This calibration is accomplished by TAI, <u>and under no circumstances should the setting of any circuit board trimmer be tampered with unless under the direct supervision of an authorized TAI representative</u>.

5.2 <u>Output Circuit.</u> The Series 310 output circuit (meter, alarm comparator, and external signal) has been designed so that when the instrument is properly calibrated, precisely one (1) volt potential difference exists between the slider and ccw terminal of the span potentiometer (P1), when the full scale (any range) oxygen is being sensed by the cell. TAI standardizes the output to within ± 0.5 mv DC with a differential volt meter, and then adjusts the meter (trimmer R18) so that is reads exactly full scale. The output signal can be preset to meet the customer's requirement through the proper selection of a voltage divider (R15 and R16).

5.3 <u>Alarm Comparator Circuit</u>. By standardizing the available full scale voltage presented by the oxygen measuring circuit, TAI is able to provide highly accurate alarm control circuitry as an option (see Section 1.3.1).

The 10-turn set point potentiometers (P3 and P4) of the circuit are powered from a secondary power supply that also has been adjusted (trimmer R34) so that precisely 1 volt appears across the potentiometers. A comparison of the signal magnitudes being received from the potentiometers and the oxygen amplifier is then made by the differential amplifiers (A3 and A4) in the alarm relay control circuits. As the oxygen signal level passes through coincidence

with the signal being received from the potentiometers, the transistors (Q9 and Q10) energize or de-energize the switching relays (K2 and K3). The circuit can be configured so that either relay will operate above or below set point by transposing the signals at the inverting and non-inverting inputs of the differential amplifier.

6. SPECIFICATION DATA

6.1 TAI Sales Order Number:

6.2 Instrument Model Number: 310.

6.3 Instrument Serial Number:

6.4 Micro-fuel Cell Class:

6.5 Accuracy: ± 2% of scale at constant temperature; ± 2% of scale or ± 5% of reading, whichever is greater, over the operating temperature range.

6.6 Operating Temperature Range: 30 to 125°F.

6.7 Response and Recovery: At the specified flowrate (0.25 scfh), 90% in 10 seconds on the X10, X100 and X1000 ranges, and 90% in 60 seconds on the X1 range.

6.8 Output Signal:

6.9 Ranges of Analysis:

| | | |
|---|---|---|
| X1 : | 0-10 | ppm Oxygen. |
| X10 : | 0-100 | ppm Oxygen. |
| X100 : | 0-1,000 | ppm Oxygen. |
| X1000: | 0-10,000 | ppm Oxygen. |

6.10 Recommended Span Gas: Atmospheric air.

6.11 Alarm Set Point #1:

6.12 Alarm Set Point #2:

310

## TAI SERIES 310

## RECOMMENDED SPARE PARTS LIST

| QUANTITY | PART NO. | DESCRIPTION |
|---|---|---|
| *1 | R-179 | Relay, P&B KHP17D11-24V |
| 2 | F-51 | Microfuse, ½ Amp. |
| * 2 | L-32 | Lamp, G.E. #327 |
| 1 | C-6689 | Micro-Fuel Cell, Class B-2 |
| 1 ** | C 8932 | measurement p c board |
| 1 ** | C 14136 | Delay power supply p c board |

* Used in Models 310-1 and 310-2 only.

A minimum charge of $20.00 applies to all spare part orders.

IMPORTANT: Orders for spare parts must include the model and serial numbers of the instrument for which the parts are intended

Orders should be sent to:

TELEDYNE ANALYTICAL INSTRUMENTS
16830 Chestnut Street
City of Industry, CA 91748
(818) 961-9221 (213) 283-7181

TWX: (910) 584-1887 TDYANYL COID

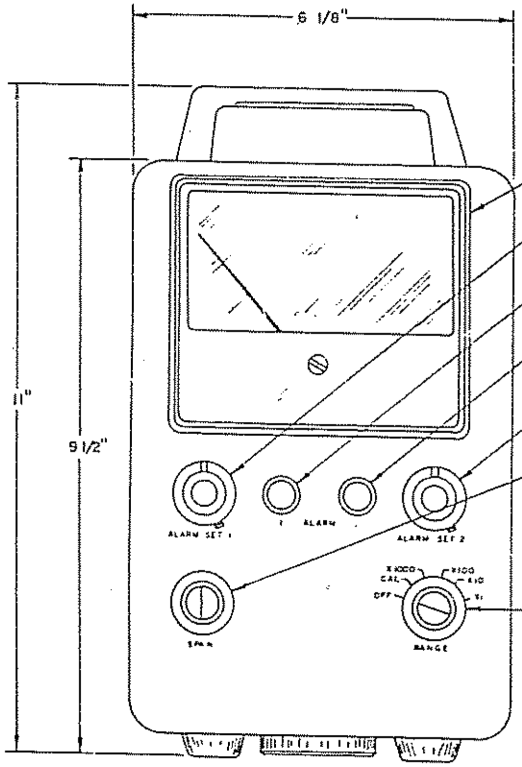
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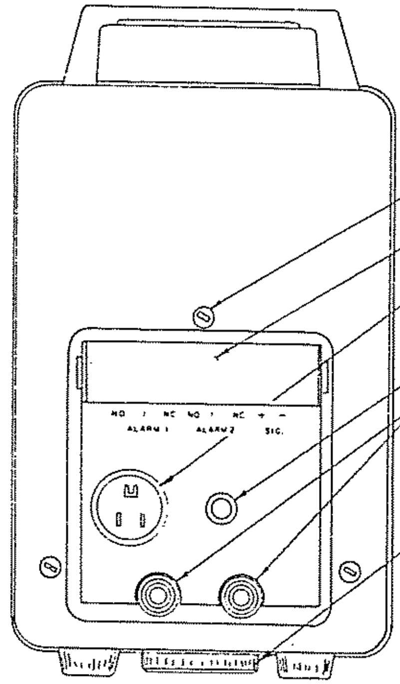
## MODEL 310

| | |
|---|---|
| B-8929 | OUTLINE DIAGRAM |
| A-14138 | $O_2$ CELL DELAY INSTALLATION DIAGRAM |
| C-8998 | SCHEMATIC |

| ISSUE NO. | APP. |
|---|---|
| 1. 11-1-68 | |
| CHANGE OUTPUT Z 2. 11-19-68 | |
| REMOVE SAMPLING PLUG 3. 12-11-68 | |

NOTE: INSTRUMENT IS 5 5/8" DEEP.




## IMPORTANT OPERATIONAL NOTES

1. ALWAYS CONNECT THE VENT FITTING FIRST, AND THEN THE SAMPLE SOURCE FITTING. WHEN DISCONNECTING, ALWAYS DISCONNECT SAMPLE SOURCE FITTING FIRST, AND THEN THE VENT FITTING. PRESSURIZING THE CELL MAY DAMAGE IT AND VOID THE WARRANTY.
2. SAMPLE FLOWRATE SHOULD BE 0.1 TO 10 LITERS/MIN. IF REQUIRED, THE SAMPLE PRESSURE CAN BE REDUCED BY USING EITHER A REGULATOR OR THROTTLE VALVE.
3. TO CALIBRATE THE INSTRUMENT WITH AN AIR SAMPLE, PLACE THE RANGE SWITCH ON THE CAL. POSITION, INSTALL AN OPEN FITTING IN ONE SAMPLE PORT, AND A PLASTIC TUBE EQUIPPED FITTING IN THE OTHER PORT. GENTLY DRAW AIR INTO THE INSTRUMENT BY SUCKING ON THE PLASTIC TUBE. NOTE THE METER READING. WHEN IT STABILIZES, UNLOCK THE SPAN CONTROL AND ADJUST IT UNTIL THE METER POINTER IS IN COINCIDENCE WITH THE CAL. MARK ON THE METER SCALE, AND RELOCK THE SPAN CONTROL. REINTRODUCE SAMPLE GAS (OR A LOW PPM OXYGEN GAS) IMMEDIATELY AFTER CALIBRATION.

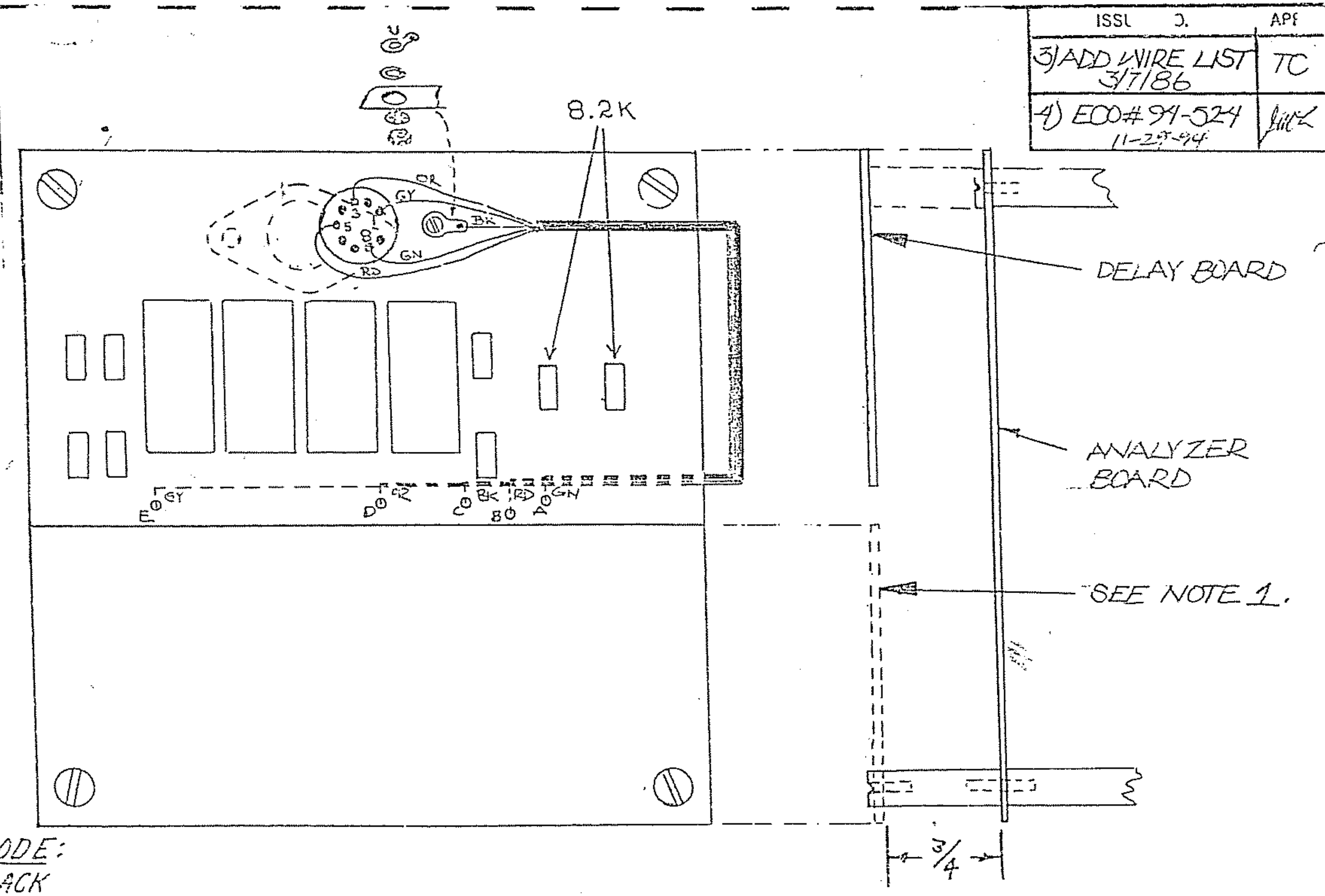
## OUTPUT CIRCUITRY OPTIONS

1. ALL MODELS OF THE INSTRUMENT FEATURE AN OUTPUT SIGNAL. UNLESS OTHERWISE SPECIFIED, THE OUTPUT IS 0-1 VDC. THE SIGNAL IS SUITABLE FOR DRIVING A DEVICE WITH AN INPUT IMPEDANCE OF 10,000 OHMS OR MORE
2. MODELS 310-1 AND 310-2 FEATURE INTEGRAL ALARM CIRCUITRY. THE ALARM CIRCUITRY ACTUATES A RELAY AS THE $O_2$ CONCENTRATION PASSES THROUGH THE SET POINT. THE ALARM POINT IS DETERMINED BY THE SETTING OF THE ASSOCIATED DIAL EQUIPPED CONTROL. THE DIALS ARE 10 TURN, 1,000 DIVISION DEVICES. CUSTOMER RELAY CONTACTS ARE RATED AT 5 AMPERES (NON INDUCTIVE). RELAYS ARE ENERGIZED ABOVE OR BELOW SET POINT (AT THE CUSTOMERS DISCRETION). SEE THE APPLICATION SECTION OF THE MANUAL TO DETERMINE RELAY OPERATION. NO INTERACTION BETWEEN ANALYSIS AND ALARM CIRCUITRY EXISTS. THE FOLLOWING SPECS. ARE APPLICABLE: 0.1% SENSITIVITY, 0.25% ACCURACY, AND 0.1% HYSTERESIS.

| TOLERANCE UNLESS OTHERWISE SPECIFIED | FRACT. ± 1/64 | DEC. ± .003 | ANGULAR ± 1/2° |
|---|---|---|---|
| TELEDYNE ANALYTICAL INSTRUMENTS<br>A DIVISION OF TELEDYNE INC.<br>PASADENA, CALIFORNIA | | SCALE | 11-1 DATE 68 |
| | | MATL: | |
| PORTABLE TRACE OXYGEN ANALYZER<br>SERIES 310<br>PICTORIAL DIAGRAM | | FINISH: | |
| | | DR S / ENGR | APP |
| | | DWG No. B-8929 | |

| | |
|---|---|
| GREY | / |
| BLACK | 10 |
| ORANGE | 8-1/2 |
| RED | 9-1/2 |
| GREEN | 9-1/2 |

| ISSU | D. | APP |
|---|---|---|
| 3) ADD WIRE LIST 3/7/86 | | TC |
| 4) ECO# 94-524 11-29-94 | | [illegible] |




COLOR CODE:
BK = BLACK
GY = GRAY
GN = GREEN
OR = ORANGE
RD = RED

NOTES:

1. ALARM BOARD; USED ONLY IN INSTRUMENTS WITH ALARM CIRCUITS



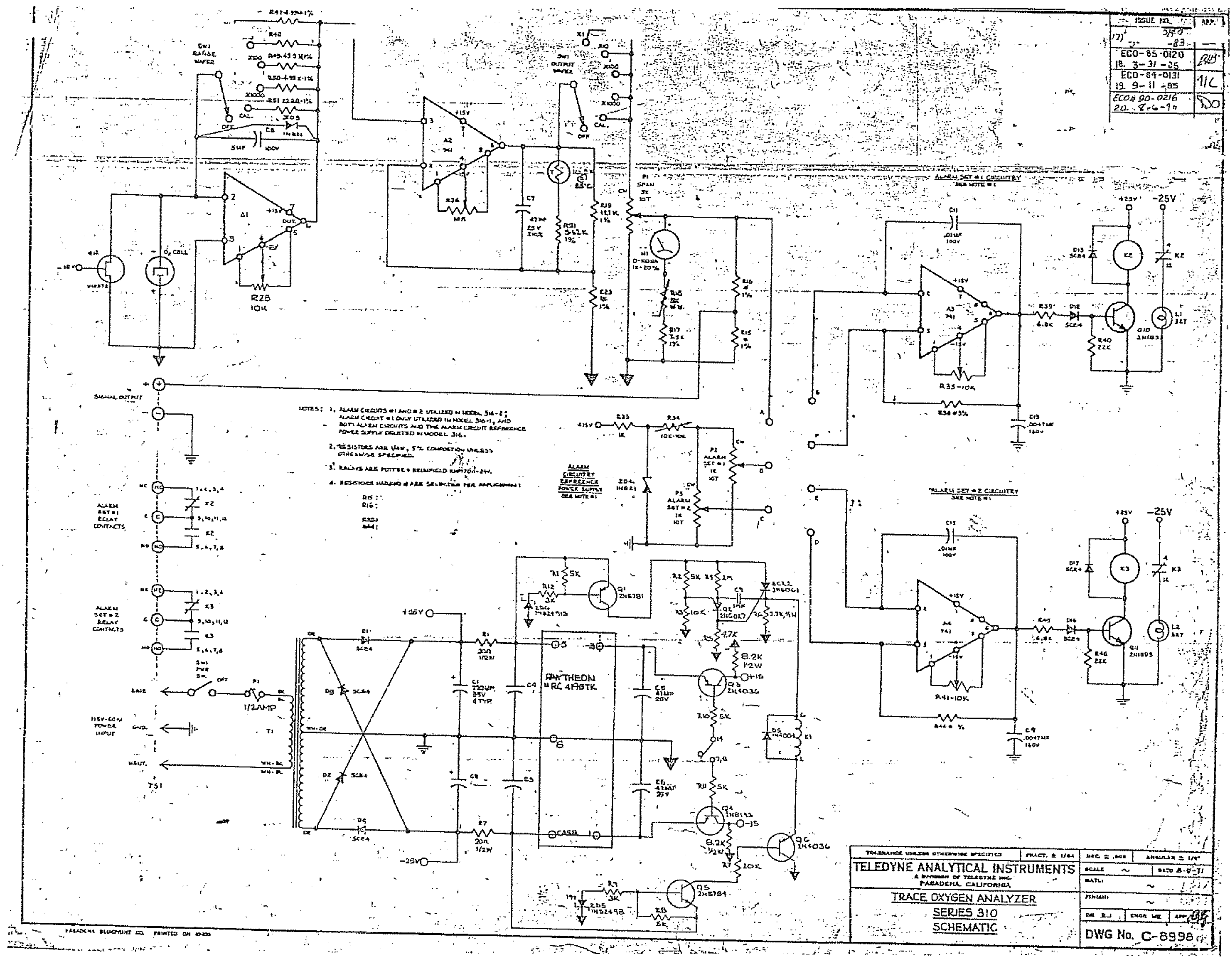
| TOLERANCE UNLESS OTHERWISE SPECIFIED | FRACT. ± 1/64 | DEC. ± .005 | ANGULAR ± 1/2° |
|---|---|---|---|

TELEDYNE ANALYTICAL INSTRUMENTS
SAN GABRIEL, CALIFORNIA

O$_2$ CELL DELAY BOARD
INSTALLATION DIAGRAM
FOR MDL'S: 310, 316, 317, 318.

| | |
|---|---|
| SCALE FULL | DATE 1-29-76 |
| MATL: — | |
| FINISH: — | |
| DR ES | ENGR [illegible] APP |

A-14138

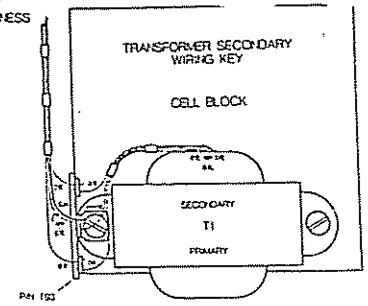


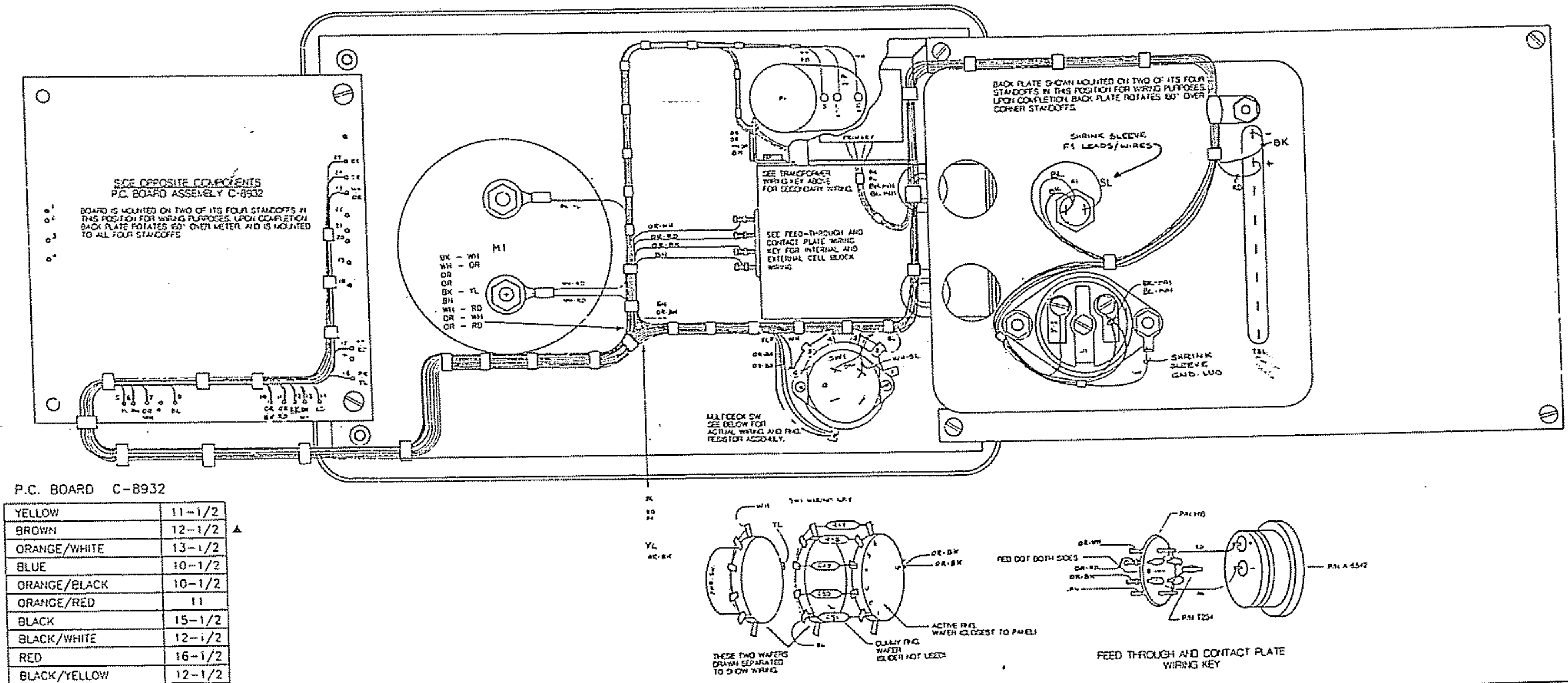
ISSUE NO.
ECO-85-0120
18. 3-31-85
ECO-84-0131
19. 9-11-85
ECO# 90-0216
20. 8-6-90
SW1 RANGE WAFER
X100
X1000
CAL.
OFF
O2 CELL
R28 10K
A1
A2
SW1 OUTPUT WAFER
X10
P1 SPAN
SIGNAL OUTPUT
ALARM SET #1 CIRCUITRY SEE NOTE #1
ALARM SET #2 CIRCUITRY SEE NOTE #1
R35-10K
R41-10K
+25V
-25V
NOTES: 1. ALARM CIRCUITS #1 AND #2 UTILIZED IN MODEL 316-2; ALARM CIRCUIT #1 ONLY UTILIZED IN MODEL 316-1, AND BOTH ALARM CIRCUITS AND THE ALARM CIRCUIT REFERENCE POWER SUPPLY DELETED IN MODEL 316.
2. RESISTORS ARE 1/4W, 5% COMPOSITION UNLESS OTHERWISE SPECIFIED.
3. RELAYS ARE POTTER & BRUMFIELD KHP17D11-24V.
4. RESISTORS MARKED # ARE SELECTED PER APPLICATION
ALARM CIRCUITRY REFERENCE POWER SUPPLY SEE NOTE #1
ALARM SET #1 RELAY CONTACTS
ALARM SET #2 RELAY CONTACTS
SW1 PWR SW.
1/2AMP
115V-60Hz POWER INPUT
LINE
GND.
NEUT.
TS1
RAYTHEON #RC 4195TK
CASE
TELEDYNE ANALYTICAL INSTRUMENTS
A DIVISION OF TELEDYNE INC.
PASADENA, CALIFORNIA
TRACE OXYGEN ANALYZER
SERIES 310
SCHEMATIC
DATE 8-9-71
DWG No. C-8998

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL INSTALLED WIRING IS TEFLON INSULATED, STRANDED, TINNED, 22GA.
2. CABLES 1, 2, 3 & 4 ARE BELDEN #8265, 22GA., TEFLON INSULATED AND JACKETED COAXIAL CABLE.

| REV | DESCRIPTION | DATE | APP. | REV. BY |
|---|---|---|---|---|
| 10 | INC. ECO# 95-824 | 11-29-95 | J.G. | M.V. |
| 11 | INC. ECO# 96-1228 | 12-11-96 | A.A. | M.V. |




R47 : 4.99M . P/N R500
R48 : 499K . P/N R502
R49 : 49.9K . P/N R313
R50 : 4.99K . P/N R411
R51 : 226 Ω . P/N R501

P.C. BOARD C-8932

| | | |
|---|---|---|
| YELLOW | 11-1/2 | |
| BROWN | 12-1/2 | ▲ |
| ORANGE/WHITE | 13-1/2 | |
| BLUE | 10-1/2 | |
| ORANGE/BLACK | 10-1/2 | |
| ORANGE/RED | 11 | |
| BLACK | 15-1/2 | |
| BLACK/WHITE | 12-1/2 | |
| RED | 16-1/2 | |
| BLACK/YELLOW | 12-1/2 | |
| WHITE/RED | 12-1/2 | |
| WHITE/ORANGE | 17 | ▲ |
| ORANGE | 18-1/2 | ▲ |
| ORANGE | 18 | ▲ |

ADD-ON (JUMPERS)

| | | |
|---|---|---|
| GREEN | 16-1/2 | |
| ORANGE/BLACK | 11-1/2 | ▲ |
| WHITE/GREY | 21 | ▲ |
| WHITE | 16 | ▲ |
| GREY | 21 | ▲ |
| WHITE/RED | 13 | |

| ITEM | QTY | PART NO. | DESCRIPTION |
|---|---|---|---|
| | | | BILL OF MATERIAL |

DO NOT SCALE DWG

TOLERANCE UNLESS OTHERWISE SPECIFIED: ANGULAR ±1/2° LINEAR .X = ±.1 .XX = ±.02 .XXX = ±.010

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Teledyne Analytical Instruments
A business unit of Teledyne Electronic Technologies
CITY OF INDUSTRY, CALIFORNIA 91748

| SIGNATURES | | DATE |
|---|---|---|
| DRFT: | R. JOHNSON | 7-31-68 |
| CHK: | | |
| APPR: | J.M. LAUER | 11-29-94 |
| ENGR: | | |
| S.O. | | |
| CAD ID | NONE | |

S/ I/ N/ P/ O/ F/ REFERENCE

TITLE: WIRING DIAGRAM TRACE OXYGEN ANALYZER MODEL 310

MATL.

SCALE: FULL

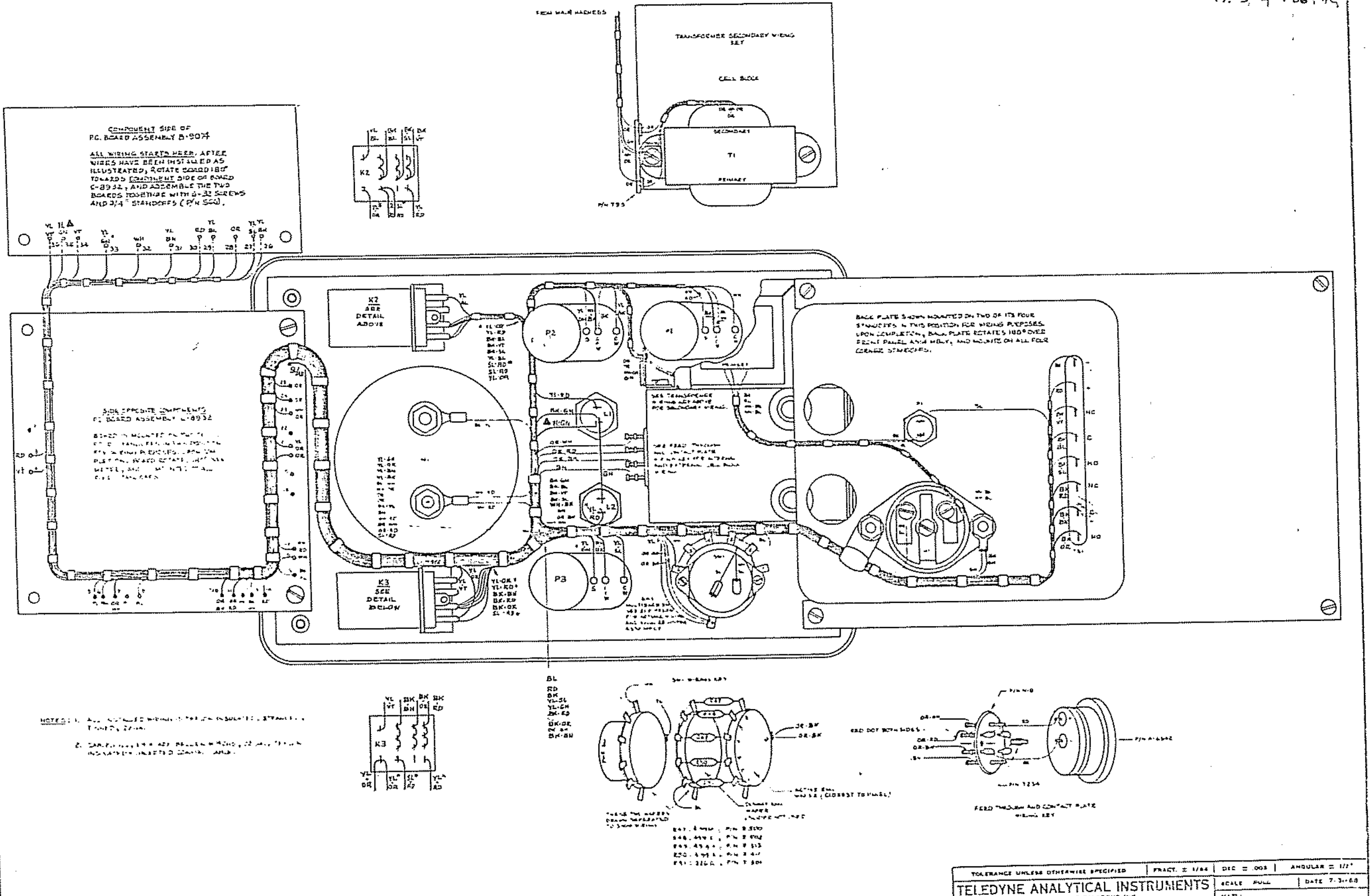
SM

SHEET 1 OF 1

DWG NO. C-8999

REV .11

REVISED + REDRAWN 9-11-72
ECO- 3-31-85
MOVED YL-OR WIRE FROM K2 TO K3 7. 3-4-86




NOTES: 1. ALL INSTALLED WIRING IS ... INSULATED, STRANDED ...
2. ...

| | | | |
|---|---|---|---|
| TOLERANCE UNLESS OTHERWISE SPECIFIED | FRACT. ± 1/64 | DEC ± .005 | ANGULAR ± 1/2° |
| TELEDYNE ANALYTICAL INSTRUMENTS<br>A DIVISION OF TELEDYNE INC<br>PASADENA, CALIFORNIA | SCALE FULL | | DATE 7-3-68 |
| TRACE OXYGEN ANALYZER | MAT'L ~ | | |
| MODEL 310-2 | FINISH ~ | | |
| WIRING DIAGRAM | DR EJ | ENGR | APP |
| | DWG No. C-9003 | | |

PASADENA BLUEPRINT CO PRINTED ON ...